NAVIGATION OF THE HUDSON RIVER.

[To accompany bill H. R. No. 159.]

January 8, 1834.

Mr. Selden, from the Committee on Commerce, made the following

REPORT:

The Committee on Commerce, to which was referred the petition of merchants and owners of vessels in the city of New York, asking for an appropriation to remove obstructions in the Hudson river, in the State of New York, respectfully report:

That a bill was passed in both Houses of Congress, in the year 1832, for the purpose of improving certain harbors, and the navigation of certain rivers therein mentioned; in which bill an appropriation of seventy thousand dollars was made for the improvement of the navigation of the Hudson, to be expended according to a plan submitted through the Department of War, which bill did not become a law. The petition relates to obstructions in said river, to remove which said appropriation was made. Your committee further report that they have examined the said plan, prepared under the direction of the Topographical Bureau, by De Witt Clinton, United States Civil Engineer, and contained in document 189 of the House of Representatives, first session of the twenty-second Congress.

That said report contains a full and minute description of the obstructions in said river which require to be overcome, and a plan of improvement, and refers to a series of maps, on which are delineated the course of said river, its channels, soundings, and the various particulars necessary to the full understanding of the subject. The section of the river described in said plan and maps commences at the point where the waters of the Erie and Champlain canals unite with said river at the north, and extends down the river about twenty miles, and the obstructions exist at different points through this section. The plan of improvement proposed by the engineer consists in excavating and straightening the channel, and contracting its width, where required, by parallel piers. The whole estimated expense is $221,504 10. Your committee have had their attention directed to the character and extent of the commerce on this part of the Hudson river, and to the description of tonnage ordinarily employed. The Erie and Champlain canals constitute almost the only outlet for the vast products of the western and northern parts of the State of New York, and also to a great extent for those of Ohio, the Territory of Michigan, part of the Canadas, and a large part of the State of Vermont, and

through which those sections of country receive their supplies from the seaboard. At the cities of Albany and Troy the mode of transportation is changed, and the vessels employed in the trade on the Hudson vary in their tonnage from 50 to 150 tons impelled by sails, and 100 to 300 tons by steam. That the vessels employed in the trade consist not alone of those navigating between the city of New York and those places, but a very considerable number are employed coastwise to the Eastern and Southern States. Your committee have been presented with statements in which full confidence may be placed, and by which it appears that the property transported on the Hudson, to and from the city of Troy alone, amounts to 300,000 tons, and, at a reasonable estimate, that to and from the city of Albany is double the quantity; making in the whole nearly one million of tons of property of every description, and requiring an amount of tonnage greater than is required for the domestic and foreign commerce of most of our commercial cities. Your committee further report, that during the spring and early part of the summer the depth of water in the river is ordinarily sufficient to allow the free passage of vessels of the burden required for the navigation, but that for more than half the period in which the river is free from ice, the obstructions are so great as frequently for days to prevent the passage of loaded vessels, and the channel is interrupted by those laying on the bottom, to the number of thirty and upwards at a time.

In conclusion, your committee consider the improvement a national work, whereby several of the States, and a large extent of territory belonging to the General Government, are to be greatly benefited; and they recommend that the plan above referred to should be carried into execution, and that the improvements should be commenced at such points as shall facilitate, as early as possible, the navigation employed within the limits referred to in said plan, having regard to economy in making the improvement and stability of construction.

Letter from the Secretary of War, transmitting a copy of the survey and report for the improvement of the Hudson river.

Department of War,
March 30, 1832.

Sir: In obedience to the resolution of the House of Representatives of the 15th instant, I have the honor to transmit, herewith, a copy of "the survey and report for the improvement of the Hudson river."

I have the honor to be,
Very respectfully,
Your obedient servant,
LEWIS CASS.

Hon. Andrew Stevenson,
Speaker of the House of Representatives.

TOPOGRAPHICAL BUREAU,
March 30, 1832.

SIR: I have the honor to lay before you the report and drawings of a survey made by De Witt Clinton, Esq., of a part of the Hudson river, near Albany, called for by a resolution of the House of Representatives of the 15th instant.

With great respect,
I remain, sir,
Your obedient servant,
J. J. ABERT, *Lt. Col. T. E.*

HON. LEWIS CASS, *Secretary of War.*

To Lieutenant Colonel JOHN J. ABERT, *Topographical Engineer:*

SIR: I have the honor to submit the following report on a hydrographic survey of part of the Hudson river, in the State of New York, between the village of Waterford and the foot of Schodac island, made by order of the Engineer Department, for the purpose of devising a plan for the improvement of the navigation, accompanied with such remarks, facts, estimates, and drawings, as will tend to assist in our investigations, and to correctly appreciate the amount and extent of the obstructions, and the means to be applied to overcome them effectually.

By the tenor of my instructions, my attention was directed to ascertain the extent and character of the submarine stratum of the bed of the stream; the depth of water in the various channels, and position, extent, and soils of islands; the velocity of the current; the points at which deposites accumulated; the width of the stream and its branches; and such other facts as should present themselves during my examinations.

There are in active preparation, to accompany this report, seven sheets of drawings, containing a hydrographic chart of the survey. They are marked in numeral progression, and combine a minute description of the stream, islands, shores, and channels, and to which I have added, in this report, a full account of each section of the river as delineated on the sheets.

The survey was made by measuring base lines with a chain, and ascertaining, by a theodolite, the angle of the base and angles of intersection on the opposite shores and islands on a combination of different and mixed colored flags; the soundings, by moving with a uniform velocity over different lines, and heaving a lead at equal spaces of time, and ascertaining the depth of water in feet and inches; and the work, at different places, was united by a circumferentor with the points established by the theodolite.

To reduce the soundings to the lowest condition of the river tide, registers were kept at Troy, Albany, Castleton, and New Baltimore. The surface of the river was observed in the morning, and its rise above and below that plane was repeated hourly until the labors of the day ceased. This established the rise and fall of the river during the day's operation, and the soundings were afterwards reduced to the lowest waters found in the registers, and again to the lowest condition of the stream. It will, therefore, be understood that the soundings delineated on the sheets exhibit the river in its extremest state in the summer and autumn of 1831.

The direction and force of the currents were ascertained by anchoring a boat in the stream, and permitting it to swing with the tides. Its direction was then determined by a marine compass fixed over the keel of the boat, and its velocity by a sand glass, a float, and a line.

In relation to the currents, it is proper to remark that they constantly vary with floods and tides. It would, therefore, require to establish them on principles of science, to conduct, for a long time, an expensive and laborious series of observations, which would be more useful as matters of fact, than to assist in forming a plan for the improvement of the navigation of the river.

Sheet No. 1.

1. The length of the river delineated on this sheet is four miles, and extends from the Waterford bridge to the foot of Albany street, (city of Troy.) From the Waterford bridge to the sloop lock and dam is 2 miles and 1,580 yards, and from the last point to the foot of Albany street, 1 mile and 180 yards.

2. The river at the Waterford bridge at low water is 510 feet wide, and, from bank to bank, 630 feet; at the first branch of the Mohawk, 840 feet; at the second, it is 960 feet; at Lansingburg, 760 feet. The length of the dam, pier, and sloop lock, is 1,325 feet; at the foot of Federal street, in Troy, crossing Fish island, 1,700 feet. At the foot of Albany street, and the mouth of the fourth branch of the Mohawk, 1,230 feet. The narrowest part of the sloop channel, between the sloop lock and the foot of Albany street, is 210 feet.

3. The width of the first branch of the Mohawk at its mouth is 405 feet. The second is 150 feet. The third is 530 feet. The fourth is 625 feet, measured from the lower point of Tibbett's island to the bend of the pier.

4. Velocity of current at Waterford bridge 2 feet, at the first branch of Mohawk $1\frac{3}{4}$ feet, at Waterford docks 1 foot, and at the foot of the sloop lock one foot per second.

5.

First island on map		320	yards long,	30	yards wide,	9,600	square yds.
Second	do.	150	do.	23	do.	3,450	do.
Third	do.	258	do.	25	do.	6,450	do.
Fourth	do.	163	do.	19	do.	3,097	do.
Islands below dam and sloop lock:							
Adam's island, including shoals,		467	do.	63	do.	29,421	do.
Second	do.	do. 440	do.	56	do.	24,640	do.
Hay	do.	do. 830	do.	63	do.	52,290	do.
Fish	do.	do. 967	do.	73	do.	70,591	do.
Total area of islands - - -						199,539	square yds,

The islands are all low, and are commonly inundated by the spring and fall floods. They are, however, all cultivated except Adam's. The soil is alluvion. They occupy superficially one-twelfth part of the area of the entire stream between Waterford and Troy.

6. The banks on both sides of the stream at the Waterford bridge are about 30 feet above low water, and slope at an angle of 45°. The bed of the river is slate rock, covered with a thin coat of gravel. The western margin maintains its elevation until it approaches the mouth of the first branch of the Mohawk river. From this point to the end of the sheet there

exist three islands, which separate the Hudson and Mohawk rivers. They are all low, with a light soil, except Tibbett's island, which is more elevated and sterile. The four branches of the Mohawk river, which form the islands I have alluded to, have a rapid descent, and glide over rock bottoms. The bank on the east side maintains its elevation throughout the section. The soil of the banks is a fine and coarse gravel, intermixed with slate rock.

7. The distance from the west pier of the Waterford bridge to the north point at the mouth of the first branch of the Mohawk, is 1,395 feet; and from the latter to the docks is 450 feet; and the length of the wharfing which extends to the Champlain canal is 540 feet. The deepest water opposite to the point is 7 feet, and the greatest within the branch is 8 feet, and the least depth, on a line passing directly to the east bank of the Hudson, is 6 feet, and the greatest depth of water 14 feet. The line of the deepest water runs obliquely from the bridge to the point which I have before mentioned. The deepest water in that distance is 9 feet. On a line parallel with, and immediately below the Waterford bridge, the greatest depth is 14 feet, and the least 5 feet, and at the mouth of the second branch of the Mohawk 16 and 9 feet respectively. The depth of water from the mouth of the first branch of the Mohawk to the sloop lock varies from 9 to 26 feet. There is, however, one point near the lock, on which there is but $7\frac{1}{2}$ feet water.

Between the foot of the sloop lock and Albany street, the sloop channel is confined near the east shore, and is much obstructed by strong currents and shallow water, and that portion of the stream which lies between the islands and the west bank is very shallow, and very much obstructed by shoals; and as it is, by the location of the sloop lock, out of the scale of comparison, it must be unnecessary to further allude to it.

8. The islands above the dam produce but little or no effect on the stream. Those immediately below it obstruct the water after it passes over the dam, and, during the low water, divert the largest portion of it into the east channel. In high water, the sides of the islands are very much worn by its rushing by them, and I am informed that their outlines and shoals have very much changed since the erection of the dam—the upper islands being diminished, and the lower ones increased in size.

9. The dam and sloop lock are one mile and 540 feet above the foot of Albany street. These works slacken and increase the depth of water to the village of Waterford, and formerly, I am told, the tides flowed up as far as that place. The pond is very capacious, and presents a fine basin to receive the deposite brought from the upper parts of the stream. Below the sloop lock a wharf is partially constructed to answer for a towing path, and at the head of the first island there is an old pier or jettee.

10. To increase the depth of water to 9 feet, and width of channel to 90 feet, the following excavations are necessary:

At the Waterford docks, 150 feet long, 90 feet wide, $4\frac{1}{2}$ feet deep, 2,250 cubic yards,

To remove a bar at mouth of first branch of Mohawk, 190 feet long, 2 feet deep, 90 feet wide, 1,300 cubic yards.

In the cove at the head of the sloop lock, slight excavation is necessary to give it sufficient width and depth; a tow path has been suggested above the lock, to assist vessels in ascending, but is not included in the estimate. Between the first branch of the Mohawk and the Waterford bridge, it is

not proposed to extend the improvement, as it would afford but little accommodation, or be of any public utility. To improve the east channel below the sloop lock, the following excavations are necessary:

1st.	680	feet long,	90	feet wide,	$2\frac{1}{2}$	feet deep,	5,659	cubic yards.
2d.	900	do.	90	do.	3	do.	9,000	do.
3d.	720	do.	90	do.	$3\frac{1}{2}$	do.	8,400	do.
4th.	800	do.	90	do.	1	do.	2,667	do.
5th.	900	do.	90	do.	2	do.	6,000	do.

It has been suggested, to slacken the current, and to prevent deposites in the channel now used by sloops, to construct a pier from the head of the second island to the lower end of the west side of the sloop lock. The greatest part of the water after it passes over the dam rushes into the east channel between the head of the island and the foot of the lock. The length of the pier would be 690 feet, and the depth of water in which it would be placed is 17 feet. The experiment would be a bold one, and its success doubtful. It has been also proposed to run a low dam or pier from the second island below the sloop lock to the west shore: its length would be 750 feet, and the depth of water in the branch is from 1 to 3 feet. The excavation in the river is generally gravel on the surface, but there would be danger of encountering slate rock after removing the first or second layer of soil at the Waterford docks and bar, and in the vicinity of the sloop lock.

Sheet No. 2.

1. Commences at the foot of Albany street, and includes the head of Patroon's island. The length of the section is $3\frac{3}{4}$ miles.

2. The width of the river between the foot of Albany street and the head of Tibbett's island is 1,230 feet; from the first point to the head of the pier directly opposite, is 625 feet. Between the southern corner of the dock at Port Schuyler and the eastern bank, 1,080 feet; at the village of Gibbonsville, 910 feet; at the upper branch of Heart's Mill creek, it is 1,600 feet; and the narrowest part of the sloop channel is 300 feet. The width of the branch at the lower end of Breaker's island and the east shore is 518 feet; and between Glen's or Hillhouse island, and the same side of the stream, it is 660 feet; and the width at the lower point of that island is 560 feet; and between the foot of Hanke's island and the east shore, is 820 feet; and from a point on Hanke's, near the foot of Glen's, the width is 980 feet.

3. Width of branch between Breaker's and Hillhouse islands is 200 feet; and between the last island and west shore 660 feet; width between Hillhouse and Hanke's islands 480 feet; and between the last island and western shore of river, 370 feet.

4. Velocity of current at northeast corner of pier opposite to West Troy $1\frac{1}{2}$ feet; at southeast corner of dock near Port Schuyler $7\frac{1}{2}$ inches; and a little above the head of Breaker's island, one foot eight inches per second.

5.
Breaker's island	740	yds long,	100	yds. width,	74,000	square yds.
Hillhouse	do. 2,230	do.	240	do.	535,200	do.
Hanke's	do. 1,550	do.	110	do.	170,500	do.

There are also three very small islands in the branch between the foot of

Hillhouse island and the head of Hanke's; and a fourth near the head of Cuyler's island: all of them are formed by the deposites of the stream, are low, but little elevated above common high water, and are therefore subject to be inundated in the spring and autumn; all the larger ones are cultivated, and are very productive. The lower part of Breaker's island, for an extent of several rods on the east side, was carried away in the spring flood of 1830. That side is also very much washed away by floods.

6. The east shore from the foot of Albany street to Heart's dock, below Van Buren bar, is low and alluvion; and from the last point to the end of the drawing the bank is elevated and rocky, with a narrow beach at its base. On the west side, the bank maintains a very uniform elevation of about 40 feet above the stream, and a slope of 45° for the whole distance. The soil is a very loose gravel.

7. The greatest depth of water between the foot of Albany street and Fish island is 13 feet, and between the first point and Tibbett's island 15 feet, and the least depth in the vicinity of the Troy docks is 7¾ feet.

The lateral cut from the Erie canal enters the Hudson at the mouth of the fourth branch of the Mohawk river. The depth near the lower and last lock in the cove is 3½ feet, but increases to six feet in a short distance, and at the turn of the pier it is 7 feet, and the deepest water between the last point and the foot of Fish island is 7½ feet, and the least depth 3 feet; as this part of the river does not properly belong to the improvement of the navigation of the stream, it was not examined for that purpose.

The channel from opposite the foot of Albany street is very direct to near the head of the Washington bar, inclining, however, towards the western shore. The greatest depth is 29 feet, and is generally from 14 to 16 feet, and there is none less than 10 feet.

A small bar or shoal was formed in the spring flood of 1831, opposite to the United States dock. Captain Reed says it lies 300 feet from the dock, is 50 feet long, and 50 feet wide, with a depth of about 6 feet water at low tide. The line of soundings passed on both sides of it without touching it.

A short distance above Port Schuyler, the channel changes its direction, and bends towards the east bank, and, at the point where it diverges, in the vicinity of Van Buren bar, the depth is 5½ feet, and the deepest water between that obstruction and Van Buren bar is 14 feet, but generally from 9 to 10 feet, but in places only 7 feet; at the upper end of the dock at Port Schuyler it is 12 feet, and at the lower end 7 feet.

Van Buren bar lies in the sloop channel between the east shore, directly opposite to Heart's mills and Glen island. The channel through the bar is very narrow, shallow, and crooked; the greatest depth is 10 feet, and the least 5 feet. The distance from the foot of the bar, in 8 feet water, to the lower end of Breaker's island, is 2,640 feet, and the depth in the channel varies between nine feet ten inches and fourteen feet. The water is shallow for 90 feet from the side of Breaker's island, and for 180 feet from the east shore. From the foot of Breaker's to the foot of Hillhouse island, the channel passes through Covell's shoals at a depth varying from 9 to 14 feet in the centre, and only 6 feet on one side, and 3½ on the other.

The balance of the river represented on the drawing varies in depth from 10 to 12 feet, except at part of the round shoals, where it varies from four feet ten inches to 8½ feet.

In 1825 or '6, I am informed that, in a great ice flood which accumulated on Covell's shoal, the sloop channel was changed from the vicinity of the east bank to near the shore of Hillhouse island, directly opposite.

9. A dam 660 feet long joins the upper end of Hillhouse island and the west shore, and another, 380 feet long, the last island, and the head of Breaker's.

The object of these works was to increase the depth of water on Van Buren bar by the corroding force of the increased quantity of water thrown into that channel, but, in that, the works have not been successful. In 1825, dredging was begun on the bar. The depth of water in which the excavation was commenced was 4 feet, and it is now 8 feet. The top digging for about 1 or 1½ feet was a hard cemented gravel and sand : it then became loose, and easy to be removed. The depth of water since the dredging, which was confined in a narrow channel, has been lessened by deposites brought from the upper parts of the stream. The dams are very much dilapidated, they were built about thirty years ago, and Mr. McCoun says, that when they were in perfect order, they increased the depth of water at Troy one foot. Captain Reed, of Troy, in speaking of the Washington bar, told me that the channel which has been dredged through it, does not fill up much, which he says is owing to the hard bottom, and the raising of the water by the dams before alluded to. The corporation of Troy have expended, since 1829, about 5,000 dollars in dredging between that city and Albany. A dam joins the head of Patroon and the foot of Hanke's island; it was built in 1823; the object was to exclude the tide waters from the branches back of the islands, and to increase the depth of water in the channel. The piers and docks opposite, and at the city of Troy, may be considered as producing a beneficial effect on the stream, as they have considerably increased the depth of water in the channel.

10. To secure width and depth of channel for the purpose of the trade at low water, it would be necessary to remove the shoal near the United States dock, (540 cubic yards.) and at the following points :

Washington bar,	350	feet long,	3½	feet deep,	150	feet wide,	6,806	c. yds.
Shoal	2,900	do.	1	do.	150	do.	16,111	do.
Van Buren	1,660	do.	6	do.	150	do.	55,333	do.
Covell's shoal,	1,000	do.	4¾	do.	150	do.	26,372	do.
Round shoal,	1,290	do.	3	do.	150	do.	21,500	do.

To improve the river at Van Buren bar, it is proposed to build a pier from the head of Breaker's island to the west bank of the stream. Its length would be 2,800 feet; a second one has been proposed between the foot of Hillhouse and the head of Hanke's, also to protect the side of Breaker's island and some other works ; for which, see estimate.

Sheet No. 3.

1. This drawing includes the river between the head of Patroon's island and the United States dock on the Greenbush side of the river. The length of the section is 3 miles and 1,000 feet.

2. The width of the channel between the end of the dam and Patroon's island is 350 feet, and between the east and west bank, crossing the head of Patroon's island, 1,800 feet; at the pier near the Fish-house shoals, 1,860 feet: at the Bath and Albany ferry, 1,265 feet; at the foot of the Albany

pier to Van Rensselaer's island, 1,070 feet; and at the Greenbush and Albany ferry, 1,090 feet.

3. The width of the channel between Patroon and the western bank, 140 feet; at Patroon's lower island, 660 feet; and between Van Rensselaer's and the eastern shore 150 feet.

4. The velocity of the stream opposite to Base island, $1\frac{14}{100}$ feet; at Fish-house bar, east end of dam, 1 foot 8 inches; at 300 feet off the Albany pier 1 foot, and at 300 feet from the Greenbush dock, $\frac{3}{4}$ of a foot per second.

5. Base island	600 yards long,		60 yards wide,		36,000 square yds.	
Patroon's upper	1,300	do.	70	do.	91,000	do.
Mud	510	do.	58	do.	29,580	do.
Patroon's lower	667	do.	79	do.	52,693	do.
Van Rensselaer	1,500	do.	180	do.	270,000	do.

There are also several other small islands and shoals bare at low water. The islands are all low and alluvion, and are annually changing in size and outline. All the larger ones are cultivated, and are very productive.

Patroon's second or lower island about 30 years ago was a mere shoal covered with willows; it is now much elevated and cultivated.

6. Banks of river on both sides are low, but sufficiently elevated to be above the reach of floods. The soil is similar to that of the islands.

7. The first 180 feet on the sheet is the continuation of the round shoals, and brings the channel into $9\frac{3}{4}$ feet water, and, from the last point to a bar which lies between Base and Patroon's islands, the depth is from 9 to 11 feet. The channel is, however, narrow, and will have to be increased in width. The bar I have mentioned continues 270 feet, and brings the channel into 13 feet water, which continues for 560 feet to a shoal near the foot of Base island, and extends 100 feet. The depth of water is there from 10 to 14 feet for 1,270 feet. It then becomes narrow and crooked, with a sufficient depth in the centre. It now turns towards the eastern shore, and leaves several small islands and shoals between it and the west bank.

Between the foot of Fish-house shoal and the head of Patroon's lower island, the water is shallow by these bars, and from the foot of the last island to the United States dock, near the village of Greenbush, the depth varies from 9 to 23 feet. The depth of water in the vicinity of the Albany pier is from 11 to 16 feet; at the Greenbush dock from 12 to 18 feet; and at the United States dock from 8 to 12 feet.

A very extensive shoal extends from the dock at Bath to the head of Van Rensselaer's island. The depth of water in the branch between that island and the east shore is from 2 to 5 feet.

8. The islands are all situated parallel with the stream, and have more or less effect on the currents, by contracting its width. It is probable that they will all be united on the west side of the channel in the course of a very few years, as they are now nearly so at low water, by the different bars and shoals, as will be seen by inspecting the chart.

9. A dam runs from the east bank to the head of Base island; its length is 750 feet; above and below the dam there exist very extensive shoals, which are bare at low water. The dam was built in 1823, and its object was to increase the depth in the channel, by holding back the tide and flood waters, and also to change the direction of the current, and to give it a more direct course over the Fish-house shoals.

Below the foot of Patroon's island, a pier runs from the west shore for

540 feet into the stream : it was built in 1799, with a view to remove the Fish-house shoal, but has not fully answered the purpose intended. In 1826, excavation of that shoal was commenced by a dredge worked by horse power, and continued to operate until 1830. In 1831, the steam dredge was employed for the same purpose. The channel opened was, however, injured by an ice flood in 1831.

The Albany pier and docks below it may be considered as an improvement, as they have considerably increased the depth of the stream, by contracting its width.

10. The following excavations are necessary. The soil to be removed, in all cases, is gravel, sand, and mud :

1st.	Round shoals,	180	ft. long,	1	ft. deep,	150	ft. wide,	1,000	c. yds.
2d.	Opening channel	240	do.	3	do.	150	do.	4,000	do.
3d.	Patroon's bar	270	do.	2½	do.	150	do.	3,750	do.
4th.	Base island	100	do.	4½	do.	150	do.	2,500	do.
5th.	Opening channel	270	do.	2	do.	150	do.	3,000	do.
6th.	Ditto	100	do.	1¼	do.	150	do.	694	do.
7th.	Ditto	80	do.	2½	do.	150	do.	1,111	do.
8th.	Ditto	100	do.	1	do.	150	do.	559	do.

Sheet No. 4.

1. Embraces the river between the United States dock at Greenbush and Van Wie's point; the length is 3 miles and 3,690 feet.

2. The width of the river between the United States dock and the head of Westerloe's island is 1,420 feet. Between the east bank and the first small island, 1,330 feet; at the head of the third island, 1,500 feet; between the head of Papscannee island and Bogart's, 2,550 feet; at the foot of Beacon island, 1,860; half way between foot of Beacon island and Van Wie's point, 1,775 feet; at Van Wie's point 840 feet,

3. Width of branch at the head of Westerloe island and west shore, 250 feet; at mouth of Norman's kill, 380 feet; at foot of island, 530 feet. Between Van Rensselaer's and Beacon island, 330 feet, and between Bogart's and Westerloe's, 330 feet, and between Small island and Westerloe's, 130 feet. Papscannee creek at its head is 90 feet, at its foot, on sheet, 150 feet wide.

4. The speed of the current below Bogart's island, 1 foot 8 inches : about 40 rods below foot of Beacon island, 1 foot 2 inches ; at second river buoy, one and a half feet per second.

5. Westerloe	island,	2,640	yards long,	400	yds. wide,	956,000	sq. yds.
Small	do.	767	do.	83	do.	63,661	do.
Bogart's	do.	1,243	do.	115	do.	142,945	do.
Van Rensselaer's	do.	643	do.	100	do.	64,300	do.
Beacon	do.	973	do.	126	do.	122,798	do.
Papscannee,	on sheet,	7,493	do.	633	do.	4,743,069	do.

There are three other small islands which are joined to Van Rensselaer's, and each other, at low water. They are all low, and similar in character with those already described.

6. The bank on the east side of the stream to the head of Papscannee island, is elevated about thirty feet above the river. The soil is loam

and gravel. From the last point to the end of the sheet the ground in the immediate vicinity of the stream is low and wet for a short distance. It is then more elevated.

From the boundary line of the city of Albany to P. R. Van Rensselaer's island, the west shore is elevated about 10 feet above the river. To the end of Beacon island it is more elevated and abrupt. It then becomes more abrupt and rocky, and higher than the preceding subdivisions mentioned.

7. The depth of water in the channel from opposite to the United States dock to the small island, varies from 17 to 11 feet, and the width is sufficient for the ordinary purposes of navigation. On Cuyler's bar, the water is from 6 to $8\frac{1}{2}$ feet, and at its lower end there is $9\frac{3}{4}$ feet. The channel is, however, crooked, and diverges towards the east bank of the stream. After passing Cuyler's bar it changes its direction towards the head of Bogart's island, with a depth varying from 10 to 13 feet. For 1,200 feet below the last point it diminishes from 9 feet 11 inches water to 6 feet opposite the corner of the Overslaugh dam, and increases to 9 feet opposite the head of Beacon island. At the foot of the last place designated, the water is 6 feet, and the channel in the whole distance is narrow and crooked. The depth there varies from 7 to 6 feet, with occasional holes 9 and 10 feet deep, which continues to the end of Van Wie's pier, and, after passing the latter, the depth is from 9 to 27 feet.

The depth in the branches is inconsiderable, except between the head of Van Rensselaer's and the foot of Beacon island. If we draw a line on the sheet in six feet water at the lower end of Bogart's island to the centre of the Overslaugh dam, it passes through 2 and 5 feet water, which increases, after we pass that work, to 23 feet; it then diminishes to 19 feet, and then to 9 feet, and joins the channel below Van Wie's pier in 10 feet water. This channel was formerly used for sloop navigation, but, owing to the difficulty of ascending against head winds, it was abandoned.

8. Westerloe's island and its shoals turn the channel towards the eastern shore, and Bogart's island and shoals may be considered a prolongation of the first designated. Papscannee, with its shoals, by its position, deflect the current over towards the Overslaugh dam, and to the head of Beacon island. It then runs nearly parallel with it, occasioned by Van Wie's pier: after passing the last work, its direction is similar with the course of its banks. At Van Wie's point, owing to the narrowness of the stream, the current is accelerated, and the depth increased.

9. A dam connects the head of Papscannee and the east bank of the stream: the object was to increase the quantity of water in the sloop channel. The Overslaugh dam commences at the west shore above the head of Van Rensselaer's island; its whole extent is 1,300 feet at right angles with the bank; it then changes its course, and joins the head of Beacon island 2,000 feet. The object of this work was to drive the water into the sloop channel, to receive the deposites of Norman kill, and to contract the flow of water. It has not fully accomplished the purposes intended to be secured by its construction. Van Wie's pier extends from Papscannee island, for 1,130 feet, into the stream. The plan of the work was to deepen the water on the Overslaugh bar, and to remove the one in its vicinity.

10. The following excavations are necessary:

Cuyler's bar	2,170 feet long,	2 feet deep,	200 feet wide,	32,148 c. yds.	
Channel	2,040 do.	2¼ do.	200 do.	34,000 do.	
Do.	2,680 do.	2½ do.	200 do.	49,629 do.	
Do.	820 do.	1 do.	200 do.	6,074 do.	
Do.	950 do.	2 do.	70 do.	4,889 do.	
Overslaugh	2,280 do.	2½ do.	200 do.	42,223 do.	
Winnie's bar,	1,020 do.	2 do.	200 do.	15,111 do.	

If the old sloop channel should be opened, it would require a cut 1,050 feet long, 5 feet deep, 200 feet wide; a second 50 feet long, and 3½ feet deep, and 200 feet wide: a pier would also be necessary, extending from the west shore to near the lower end of Bogart's island. This channel would be the most economical, but there would be much hazard in keeping it open, independent of the difficulty of navigating it. I have, therefore, not estimated it.

It is proposed to assist in keeping the channel open, to construct a pier from the foot of Bogart's to the head of Beacon island, and also another from the lower end of the last island. Each of these would be half a mile long. The deepest water in which they would be built is 6 feet. One-half of the length of Beacon island should be protected, to prevent the soil washing into the channel.

Sheet No. 5.

1. Commences at Van Wie's point, and ends opposite to Castleton. The length included on it is 3 miles and 3,200 feet.

2. Width of river at Van Wie's point and west side of Papscannee island 840 feet; at the head of Bear island 1,480 feet; at Winnie's point 2,010 feet; at Forbes's dock 1,380 feet; at mouth of Vlaaman's creek to lower point of Smith's island 1,930 feet; and from bank to bank 2,875 feet. Between lower point of Cow island and Sill's upper island 1,760. Between east and west bank, crossing Sill's lower island, 2,460 feet; at Civil's dock and west shore 2,000 feet.

3. Width of Papscannee creek at head of sheet 150 feet; at lower end of island 290 feet; at foot Pixtaway 450; at middle of Smith's 470 feet; at foot of Cow 630 feet. Channel between Papscannee and Pixtaway 540, and between last island and Smith 420; ditto between Smith and Cow island 440; between Bear and west shore 80 feet, and between Sill's upper island and west shore 390 feet; ditto between upper and Sill's middle island 200, and between the last island and west bank 200 feet, and between lower island and west shore 160; width at mouth of Vlaaman's kill 120 feet.

4. Force of currents 500 feet, from Van Wie's point 1 foot 8 inches. In channel, between foot of Papscannee and Pixtaway island, no current: at east end of Winnie's pier, 1 foot 7 inches per second.

5. Continuation of—

Papscannee island,	2,460 yds. long,	672 yds. wide,	1,653,120 sq. yds.	
Pixtaway do.	1,463 do.	220 do.	321,860 do.	
Smith do.	1,720 do.	280 do.	481,600 do.	
Cow do.	620 do.	117 do.	72,540 do.	
Bear do.	740 do.	160 do.	118,400 do.	
Sill's upper do.	310 do.	33 do.	10,230 do.	
middle do.	410 do.	33 do.	13,530 do.	
lower do.	380 do.	60 do.	22,800 do.	

The islands are all low, level, and alluvion, except the lower part of Papscannee, which is more elevated and uneven. They are all cultivated, and are sometimes inundated by the spring and fall floods.

6. The east bank of the stream in its immediate vicinity is low to the foot of Papscannee island. For the whole length of the Pixtaway, the shore is steep, high, and hilly, and from the foot of the last island to the upper end of the village of Castleton, the shore is low. It then becomes elevated and mountainous to the end of the drawing. The bank from Van Wie's point to Winnie's dock is rocky and uneven. The high bank then recedes from the stream, and leaves the balance of the bank low and alluvion.

7. In the channel off Van Wie's point, the water is 27 feet. It then bends towards Staat's dock, (on Papscannee island,) and the depth is 25 feet in its vicinity. From thence it turns towards the eastern shore at Winnie's point, where the water is 27 feet, and the least depth in the channel between the extreme points mentioned is 10 feet. From Winnie's point the channel is more crooked, but with sufficient depth and width to opposite the foot of Smith's island, when it is only 8½ feet for 360 feet in length. It then becomes 9 feet, and increases gradually to 16 feet, which again lessens, and again increases, to the end of the sheet.

8. By examining the drawing, it will be seen that Papscannee, Pixtaway, Smith, and Cow islands lie on the east side of the sloop channel, and that their ends so overlap each other as to present a continuous bank; they therefore may be considered as a natural pier, contracting, by their position, the channel, and deepening the water in that portion of the stream. The banks of these islands, in ascending or descending, would be taken by the navigator for the eastern shore of the river.

Bear and Sill's three islands lie close to the western bank. The first above, and the three latter below Winnie's pier.

9. Winnie's pier runs for 1,700 feet at an angle of 45° from the western shore towards Cow island. The object of the work was to deepen the water, and, by increasing the current, to effect the removal of a bar at that point; and I am informed in a letter from Messrs. Bogart and Brown of Albany, it has produced the desired object. It is, however, the general opinion of the skippers that the work is too long, and occasions too strong a current in the channel at its end. It will be seen by reference to the chart that the depth of water is very much increased on the lower side of the dam by the water shooting over it, and that the deposite is made on the upper side of the pier between the angle and the west shore.

10. The following improvements are necessary:

Excavating 360 feet long, 6 inches deep, 200 feet wide, being 1,333 cubic yards, and cutting off 50 feet from east end of Winnie's pier.

Sheet No. 6.

1. The length of the drawing is 3 miles and 3,690 feet: it commences at Civil's dock, and ends at the village of Schodac.

2. The width of the river between the southeast corner of Civil's dock and the west shore is 1,970 feet; at the mouth of Schodac creek, crossing the head of Shad island, it is 2,490 feet. From the west side of the first island to the opposite bank, crossing the lower end of Shad island, it is

1,860; crossing at the head of Plaat island, 2,180 feet; and at the foot of Plaat island, 1,340 feet.

3. The width of Schodac creek between the northwest corner of island and the mouth of Downing's creek, is 530 feet; at the northwest corner it is 180 feet; at the mouth of a small brook on the east shore it is 300 feet; and at the foot of Schodac island it is 510 feet. The width of the channel between the head of Shad and the west shore of Schodac island is 1,860, at the narrowest part it is 1,020, and at the lower end of the first island it is 1,520 feet. The width of the Hellegat channel at the head of Plaat island is 690 feet; at the head of the lower Schodac island it is 540 feet, and at the foot of Schodac island it is 840 feet. The channel between Plaat and lower Schodac island at the head is 510 feet, at the narrowest place 130, and at the lower end 365 feet wide.

Channel between Shad island and west shore: at its head is 410 feet, narrowest place 200 feet, at the mouth of Jolly's creek 340 feet, and at the lower end 320 feet; width of Jolly creek at its mouth 140 feet, width of river between the head of Plaat island and west shore 1,510 feet.

4. No current at the mouth of Schodac creek. In Hellegat channel, near the head of lower Schodac island, 5 inches per second.

5. Islands.	Width in yds.	Length in yds.	Superficial contents in yds.
Scamerhorne's	53	400	21,200
Small*	30	177	5,310
Shad	277	1,760	487,520
Schodac	337	4,460	1,503,020
Plaat	90	2,460	217,400
Lower Schodac as represented on sheet	400	1,753	701,200

The islands are all low, soil alluvion, and in places swampy and marshy. They are all cultivated.

6. The west shore of the stream is low to the mouth of Jolly's creek, and the remainder is high, sterile, and rocky; the east bank is low and alluvion for the whole distance.

7. The depth of water in the channel at the head of the sheet is 16 feet, and the least depth represented on the drawing is 10½ feet, the greatest 22 feet, and, at the lower end of the chart, it is 11 feet.

The soundings between the lower end of Shad and Plaat island are not so numerous as on other sections of the drawings, which is owing to the buoy which was placed for a guide point, being displaced by the swell of a passing steamboat, and was not detected until the work was protracted.

8. The deep water is occasioned by the position of the different islands which all lie parallel with the course of the stream, contract the channel, and improve the depth of water as they act, and may be considered as natural piers.

It is proposed to improve the access to the docks at Castleton for vessels at the lowest tide to approach them drawing 9 feet water. The channel which would be opened, as represented by a dotted line between Civil's and Livingston's dock, is 960 feet, and would require a cut of 9 feet for the full width of the channel, and the further excavation of 2½ feet for a distance of 630 feet.

If the approach for vessels at low water was, however, confined to Liv-

* Surrounded by a very extensive shoal.

ingston's dock, which would probably be the best plan, as steamboats now land passengers from boats, and approach the docks at high water, as do also sloops and other vessels, it would require an excavation of 2½ feet for 1,260 feet in length.

Sheet No. 7.

1. The length of the sheet is four miles; it commences three-fourths of a mile above Coeyman's, and ends below the foot of Houghtailing's island.

2. The width of the river at the upper end of the sheet between the banks is 4,740 feet; at the head of Houghtailing's island it is 4,710 feet; and at the lower end of the survey it is 2,640 feet.

3. The width of the channel between the foot of Plaat island and the west shore is 1,350 feet; at the head of Mull's island it is 1,200 feet; at the head of Houghtailing's it is 2,520 feet; and at the foot of the last island it is 1,320 feet. Between Mull's and lower Schodac island it is 510 feet, and between the last island and Houghtailing's it is 600 feet. The width of the Schodac creek at Scamerhorne's dock is 480 feet; at Van Alstyne's 600 feet; and at the foot of Houghtailing's island 1,650 feet. The width of stream between Barren and Mull's island is 550 feet, and between the first island and the west shore at the mouth of a creek is 640 feet.

4. The velocity of the current between Schodac and Mull's and Plaat islands is one foot eight inches per second.

5. Remaining part of

Lower Schodac	2,200	yards long,	440	yards wide,	968,000	sq. yards.
Houghtailing's	3,440	do.	600	do.	2,064,000	do.
Mull's	2,223	do.	87	do.	194,271	do.
Barren	567	do.	160	do.	90,720	do.
Small island	367	do.	33	do.	12,111	do.

The islands are all low except Barren, which is considerably elevated and rocky.

6. Both banks of the river are elevated, hilly, and rocky.

7. The depth of water at the head of the sheet is 14 feet, and in no part is it less than 9 feet in the channel, and at the end of the survey it is 12 feet. Between Coeyman's and New Baltimore the channel is crooked, and near the foot of Mull's island it divides into two branches, with a middle ground between, which unite again above New Baltimore. Schodac creek is navigable for sloops at all times as high up as the village of Schodac. It unites with the main stream through the branch called the Hellegat. Schodac creek—commencing our view at the head of the Hellegat, the depth of water in the channel is not less than 6 feet, and increases from that to 9 feet; at the foot of Schodac island it is 8¾ feet, and off Schodac dock it is 9 feet; and the water is not less than the last mentioned depth to the foot of lower Schodac island, with occasional increases of 12 and 13 feet. It continues nearly with a uniform depth to the lower end of Houghtailing's island, and, at that point, the channel would require to be widened. The improvement of the bed of this creek is a matter of no great importance, nor is it included in the estimate. During high water, steamboats sometimes pass through it to avoid the currents in the main branch.

8. The islands are large, and, by their positions, contract the width of the stream.

10. The improvements proposed are to straighten the channels at one or two points, to erect guide lights at the separation of the channel below the foot of Mull's island, and to protect the side of the last island.

The whole length of the survey as measured on the bank of the stream is 25 miles and 498 feet. The average width of the river between the banks on the first sheet is 1,046 feet, on the second 960 feet, on the third 1,450 feet, on the fourth 1,689 feet, on the fifth 1,934 feet, on the sixth 2,250 feet, on the seventh 4,030 feet; and gives an average width of the whole length of the stream 1,893 feet, or 631 yards. The space occupied by the rivers and islands amounts to 5,757 acres, and that alone by the islands is 3,516 acres, or leaving 2,241 acres for the area of the main channel, and the different branches.

Tides.—The quantity of water running from the upper parts of the stream in the tide channels constantly fluctuates, and occasions more or less variation in the rise and fall of the tideal waters. In the spring and fall, the tides are the least sensible, but, as the river shrinks, and the supply from above diminishes, the tides rise and fall more uniformly. The following facts, ascertained from observation, will give us some light on this intricate subject :

A tide register was kept at Troy from 31st May to the 11th of June, 1831. The wind in that period blew principally from the south. The state of the tide was noted hourly from 7 o'clock A. M. to 7 o'clock P. M., making 12 hours daily. The greatest rise in any one day was 26½ inches, and the greatest fall 19½ inches ; and the most rise in an hour was 5 inches, and the most fall 7 inches.

A tide register was kept at Albany from the 27th of May to the 16th of July, 1831. The condition of the river was noted hourly from 8 o'clock A. M. to 6 o'clock P. M., which continued to the 14th of June. It was then changed to 7 A. M. and 6 P. M. The greatest rise during the above time was 32 inches, and the most fall 37 inches; and the rise in an hour, with a strong southerly wind, was 9 inches, and the fall in an hour, with a moderate northeast wind, 8 inches.

A tide register was kept at Castleton from the 20th of June to the 7th of July. The rise and fall of the tide was noted hourly from 7 o'clock A. M. to 6 o'clock P. M. The winds were very variable, and there was considerable flood water in the river. The most rise was 34 inches, and the most fall 37 inches. The greatest rise in an hour 11 inches, and the greatest fall 7 inches.

A tide register was kept at New Baltimore from the 9th to the 16th of July, 1831. The hours of observation the same as at Castleton. The highest tide 48 inches, and the lowest 51 inches. The greatest rise in an hour was 15 inches, and the most fall 10 inches.

It therefore appears that the highest and lowest water was—

Place.	Highest water.	Lowest water.
At Troy	26½ inches	19½ inches.
Albany	32 do.	37 do.
Castleton	34 do.	37 do.
New Baltimore	48 do.	51 do.

From the registers we collect the following facts : 1st. That the tides run out longer than they run up. 2d. That the tides fall with greater rapidity than they rise. 3d. That the velocity of the ascending tides are

increased by southerly winds. 4th. That when southerly winds prevail strongly, the river does not fall so low as it rises, unless it is in the state of flood. 5th. When northerly winds prevail, the tides fall lower than they rise. 6th. When the river is in the state of high flood, the tides do not act, although the river swells and falls, occasioned by the flood waters being obstructed by meeting the ascending tides.

The common difference in time between the rise and fall of the tide waters at Albany and Troy varies from one to one and a half hours. By the tide registers it appears that, in some instances, while the river was actually swelling at Troy, it had commenced falling at Albany. This is to be attributed to accidental floods and winds, and the curve in the river at the head of Breaker's and Hillhouse islands.

At Albany, the tides are from $\frac{3}{4}$ to $1\frac{1}{4}$ hours longer in falling than at Castleton, and the difference in time between the tides at the first place and New Baltimore is from $1\frac{1}{2}$ to 2 hours, accompanied by the same general phenomemon I have remarked in speaking of Troy.

From the facts I have mentioned, it became necessary to establish the lowest water in the stream, that further observations should be made. Fixed points were therefore left at the places the registers were kept, and the distances measured from them to the lowest tide which occurred during the survey. Mr. Hagner was instructed to revisit those places when the river subsided to its lowest condition, and compare the two measurements. From his observations, it appears that the river had subsided at the Waterford bridge, since the survey, two feet; at the upper end of the sloop lock one foot nine inches; immediately at the foot of the sloop lock two feet nine inches; at Troy one foot ten inches; at Albany two inches; at Castleton eleven inches; and at New Baltimore one inch.

Winds.—The prevailing winds at Albany, according to the meteorological table kept by Professor Beek, was, in 1828 and 1830, as follows:

Course of winds.	Years.	Days.	Years.	Days.
North	1828	$55\frac{1}{2}$	1830	30
Northeast	do.	6	do.	12
East	do.	7	do.	2
Southeast	do.	$22\frac{1}{2}$	do.	$36\frac{1}{2}$
South	do.	140	do.	$102\frac{1}{2}$
Southwest	do.	$29\frac{1}{2}$	do.	28
West	do.	66	do.	50
Northwest	do.	$59\frac{1}{2}$	do.	104

From this table, it appears that the winds prevail from the south for a longer period than from any other quarter; and, in 1828, it ranged from southeast, south, and southwest, 192 days; and from the same direction in 1830, 167 days; and for the same periods, from northeast, north, and northwest, 121 and 146 days.

Currents.—The bends, the banks, and bed and slope of the stream, have a powerful influence on the speed and force of its currents, and on their local situations. They therefore properly come under three classes. The first are rivers situated above tide waters, in which the current is uniformly in one direction. The second is of a mixed character, combining a rush of water in floods, and the ebbing and flowing of tides. The third and last are streams in which the rise and fall of the tides are nearly uniform. Many rivers, however, combine all these classes, and such in fact does the

Hudson. Above the city of Troy, the first class is applicable; the second as low down as the city of Hudson, and in high floods to the village of Poughkeepsie; and the third from that point, passing by the city of New York, to the ocean.

If we suppose the river between the city of New York and Troy had a uniform width, course, and depth, and that its supply above the last point was cut off, the ebbing and flowing and heights of the tides between the extreme places would be governed by the distance from the ocean, which would occasion so small a variation of height in theory, that it would produce little or no alteration in the planes of high and low water. But if the stream should become gradually more crooked, shallow, and narrow, and its channels obstructed by islands and shoals, the ascending tide having to overcome the friction on the bottom and the sides of the stream, and other obstructions, the velocity would be proportioned to the obstructions encountered, and the pressure of the ascending waters; and if these obstructions were met at the same points by the up and down tides, the currents at those places would always, at certain hours in the day, be equal. But frequently what would be a positive impediment to the ascending current, would offer no obstruction to the descending one. The local character of the stream has therefore more influence in these matters than is generally admitted. The ascending and descending currents are therefore accelerated or retarded in their progress. If we imagine a curve in the river, the force of currents being equal on both sides, a bar would be formed at the vertex of the bend. But, in either of the two first classes of streams, this bar would form on the lower side of the bend, and not at the vertex; and, at expanded widths where the currents were diminished in velocity, bars, shoals, and shallows would accumulate. But, at the mouth of the stream, owing to the action of winds and waves, bars would be formed.

In the class first examined, the stream was considered as being within the entire scope of tide waters. I shall now take the second or mixed class. The velocity of the ascending tides is checked by the quantity of water flowing into the tide channel, or its speed is impeded in proportion to the intensity of the impact of the waters, for the particles of all fluids are considered by writers as globular or spherical bodies; but if we remove the ascending pressure, the current would be equally accelerated by the flow of water from the upper parts of the river, as the ascending tide was retarded by it. It is therefore apparent that the force of the down current would be greater, and that it would continue longer to run out, than the tide upwards. But let us suppose that the river is swollen by rains, and that the whole channel is filled with flood water; in this case, the ascending tides, owing to the greater intensity of the pressure from above, are held back until an equilibrium between the currents ensues, and the flood waters from that point become inactive until the tides begin to run out; it then sweeps down with greater force than before, until its power is lost in the increased depth and width of the stream.

The flood water being held back by the ascending tide, and its velocity checked, it will occasion an accumulation or swelling of water, which falls again to the flood height on the pressure being removed. This variation is by some writers erroneously attributed to the tide waters passing under the flood, and raising it up.

At the meeting of the flood and tide waters, bars would be formed. But

the bottom and the sides of the stream are more corroded by the down than the up current, and the former is never less than at extreme low water, while the latter constantly fluctuates. The deposites in the stream would, therefore, be constantly on the move down, and there would be no danger of the ascending tides forcing them back. But it may be asked, why do bars and shoals form at various points? This is owing to the deposites carried down in floods, and left by local obstructions at the head of islands, at bends, at increased widths of the river where the currents are diminished, and by other causes.

We have, therefore, the following facts relating to the section of river to be improved:

1st. That all heavy materials are deposited in the upper parts of the stream, and the lighter lower down; for all the bars above Albany are gravel and other heavy soils, while all below Albany are sand and other lighter deposites.

2d. That the dam between Troy and Waterford has, in some degree, prevented the rapid deposites which, in former years, were making in the stream.

3d. That the current is, in all cases, stronger down than upwards, unless the river is very low, and strong southerly winds prevail.

4th. That the obstructions are occasioned by local causes, which are to be removed by artificial works, and by other means.

Rivers.—Fluids, unless agitated by winds or other causes, gravitate in *proprio loco.* It, therefore, follows that the surfaces of stagnant fluids are segments of a sphere, as they all gravitate towards the centre of the earth; but these particles yield to any force impressed, or they will remain at rest until put in motion by some foreign power, such as winds, floods, tides, or the sudden emission of an increased quantity of fluid matter, to produce motion or velocity, which is again increased by the slope over which it rolls, or the height from which it falls. When it, therefore, moves uniformly, the resistance is equal to th accelerating force, and the difference between its bottom and top velocities are proportional to the square root of the superficial velocity. But, without entering into further remarks, I will assume facts which have been established by observation and experience.

1st. The extent of deposites in all streams depends on the soils through which they pass, and on the character of their tributary branches.

2d. As the force of the currents vary, so do also the quantity and extent of deposites.

3d. Deposites always occur where there is the least velocity.

4th. Streams raise their beds at some points, and lower them at others.

5th. Shoals form where the river has the greatest width, and at bends, and where it is the narrowest, it is the deepest.

6th. Bars are formed by counter currents, or by eddies, or by the direction of the current being suddenly changed from its course by foreign obstructions.

7th. All streams are higher at the upper than at the lower side of a bend; a cut through such point would therefore accelerate the velocity of the stream.

8th. The tendency of all streams is to raise their banks and islands, by overflowing them in the spring and autumn, and depositing the soils which they hold in solution on them.

9th. The waters of all streams contain more or less foreign matter, and their deposites, though small, are going on perpetually. The stream contains the least quantity when at its lowest condition, and the greatest when it is the most swollen.

10th. The heaviest soils are deposited in the upper parts; the lighter in the lower sections of the stream.

11th. The greatest slopes of all streams are near their sources, and they diminish in fall as they approach the ocean.

12th. Ice is a powerful agent in effecting changes in the beds of streams. Its force and strength depend on its thickness, and the momentum of currents.

To collect such useful information relating to the navigation of the stream as could with confidence be relied on, I addressed several communications to different gentlemen, containing queries, and soliciting their replies; and it is with great pleasure that I return my sincere thanks to them for their promptness in furnishing me with the results of their observations and experience. The first reply to the queries is from William James, Esq., of Albany, chairman of the Chamber of Commerce, after a joint consultation with the mayor of the city, and other individuals. The next from Townsend McCoun, Esq., of Troy, one of the commissioners appointed by the Legislature of the State of New York, in 1819, to ascertain the best mode for the improvement of the navigation of the Hudson river.

Query 1st. The length, breadth, draught, and tonnage of vessels employed in the trade of the river?

Reply of Mr. James. "The average length of the Albany sloops is 75 feet, breadth 25 feet, draught of water when loaded 9 feet, and they average 125 tons: vessels come here, and several belong to the city, which exceed these dimensions in every particular."

Reply of Mr. McCoun. "Sloops from 50 to 55 feet keel, and from 20 to 25 feet beam, drawing from 6 to 8 feet water, loaded from 70 to 120 tons. Scows, decked, 60 to 80 feet long on deck, 18 to 23 feet wide, carry from 80 to 150 tons. Tow boats carry from 150 to 300 tons, draught from 6 to 8 feet."

Query 2d. The depth of water required by the interest, and the amount of trade at extreme low water?

Reply of Mr. James. "A depth of 8 feet water is necessary at the lowest tides; a depth of 8 feet water will be a great relief from the present difficulties, but, if it be increased to 10 feet, it would directly create a West India and whaling trade, and other foreign enterprise, which, of course, would add to the prosperity of the city, and increase the shipping and revenue of the United States Government."

Reply of Mr. McCoun. "Depth at low water should be from eight to ten feet."

Query 3d. The width of the channel necessary to be opened at the several bars to give the trade sufficient security?

Reply of Mr. James. "A width of 150 feet is necessary."

Reply of Mr. McCoun. "Width of channel from 100 to 300 feet."

Query 4th. Is the night navigation of the river important, and, if so, should beacons be provided?

Reply of Mr. James. "The progress of our vessels depends so much on the tides, as renders night navigation not only important, but indispensable; only few more beacons or buoys would be necessary."

Reply of Mr. McCoun. "Night navigation—two beacons would much accommodate the trade, as vessels go at all times in the night when they can."

Query 5th. Is there any difference in the tonnage of vessels in the spring, summer, and autumn?

Reply of Mr. James. "Vessels can and do bring and take away heavier cargoes in spring and fall than in the summer, being assisted by freshets."

Reply of Mr. McCoun. "During spring freshets, large vessels from other States frequently come here, drawing 10 and 12 feet water, and in summer season vessels come here with coal, and draw more water than those owned here, and are much impeded for want of a deep channel."

Query 6th. The average period of the continuation of the navigation?

Reply of Mr. James. "The average season of our navigation is nine months, from middle of March to middle of December."

Reply of Mr. McCoun. "Average length of season for navigation full nine months."

To secure further information, I extended my queries to Mr. McCoun, and the following are the questions, and his replies:

Query 1st. The general opinion of the efficiency of the present works erected for the improvement of the navigation of the Hudson river?

Reply of Mr. McCoun. "The general opinion in regard to the modes of improvement of the navigation heretofore practised, is considered inadequate to effect a desirable permanent navigation."

Query 2d. Do bars and shoals most increase in the spring or fall floods, and the local change in position or size of any bar or shoal within your knowledge?

Reply of Mr. McCoun. "Sand shoals are generally caused in the spring, and mostly by the ice breaking up early while strong, and lodging together in large masses, and forming great obstructions to the currents, and producing eddies, and more or less shoals."

Query 3d. Has the quantity of water running in the river at Troy diminished within twenty or thirty years?

Reply of Mr. McCoun. "The quantity of water running may have diminished within twenty or thirty years, but the depth of the channel has been increased two feet within that period by the various modes adopted for that purpose."

Query 4th. The effects produced by ice freshets, or by floods, on the channels opened through the different bars and shoals by the dredge?

Reply of Mr. McCoun. "The effects of freshets in the channels above, and I believe below Troy, where not obstructed by ice, and the channel is straight generally, has not been injured; but where the channel is crooked in the vicinity of islands, causing eddies, sand shoals are frequently created."

In a letter I received from Captain John Bogart, and Allen Brown, Esq. of Albany, who formerly acted as commissioners for the improvement of the navigation of the Hudson river, they remark: "Our views of the improvement are, that by diverting the water into one uninterrupted course, either by connecting the different islands with the main land, or by running piers from different points in the river as low down as New Baltimore, if no further, (the water being so much better below Winmes bar than above,) we think that the pier built above would have the desired effect in removing the obstructions now so troublesome."

This opinion of Messrs. Bogart and Brown is the same generally ex-

pressed by those persons interested in the improvement of the navigation at Troy and Albany.

In the interesting report of Edmund Charles Genet, in 1820, to the Legislature of the State of New York, in proposition No. 4 of that document, he says, "that, through the city of Albany, the water is shallow where the docks form a curve, and deeper where they present a straight line to the current, as is the case below the public watering place, and at many other straight docks, solid high banks, or rocks above and below Albany." It will, however, be seen, on reference to drawing No, 3, that a very extensive pier has been constructed since his report, parallel with the river, and opposite to Albany, which has had the effect of deepening that portion of the stream. Mr. Genet, in his 11th proposition, says, "that where perpendicular rocks, straight banks, or a continuity of straight and perpendicular docks, parallel to the current, compel the water in contact with them to pursue a straight course, the bed of the river is also deeper, and the velocity protracted longitudinally, extends further than it does under the operation of dams running crosswise, as has been observed at a chain of perpendicular rocks, and at a straight bank on the opposite shore below Coeyman's overslaugh, and also at other places. The same fact has also been noticed in Italy by the celebrated Father Frisi, an hydraulic engineer of the first ability, who confessed of all the public moneys wasted in the fruitless construction of transversal dams, dykes, and jettees, to improve the streams, having a tendency to fill up their beds, would have been more wisely appropriated for the building of longitudinal docks running parallel with the stream."

In a subsequent part of his report, he says: "If the navigation of the river was to be improved by dams, I am of opinion that, to avoid any public trespasses of such a repulsive nature, and effectually to improve the navigation, without depending on system and casualties, the plan executed in Scotland, on the river Greenock, below Glasgow, by Mr. Gouldbourne, a civil engineer of great repute, would be the most eligible, inasmuch as it has a tendency to straighten the channel of a river by the alternative concentration of low dams, and to deepen the bed by local excavations performed by mud turtle, injurious to no one, but, on the contrary, reclaiming on each side of the river lands covered up by water, inasmuch as the stuff withdrawn from the bottom is lodged behind projecting piers by men constantly in that business."

Mr. Genet, in the postscript to his report, observes: "To guard against these evils, the lessons of experience, and the principles of the most esteemed European engineers, have been consulted, and they have fortified the observations made in this report, and have clearly established, as a matter of fact in hydraulics, that the water running along high perpendicular straight masses, natural or artificial, corrodes the bottom, and effectually removes the deposites seated at their base."

Among the various plans which have been suggested to improve the navigation of the river, that of building a dam and sloop lock at some point on the stream below Albany may be considered as the most ridiculous, and it may confidently be pronounced impracticable. But if it could be constructed, its durability would be doubtful, and it would injure private and public property to a vast amount, and be a serious impediment in the trade. It is true that a lock and dam is built across the stream between Troy and Waterford, but that work is no criterion to judge of the propriety of the one proposed, as the trade of Waterford and Lansingburg is

very small in comparison to that of Albany and Troy. The character of the stream is also dissimilar in every respect.

To show the comparative amount of trade above and below the dam, I procured from the collector of the sloop lock a list of the number of vessels employed in the trade above Troy. From his statement, there were seven vessels owned at Lansingburg, five at Waterford, one at Troy, and one in the city of New York. In a table politely furnished by Mr. James, of Albany, the number of vessels concerned in the trade at that place, (Albany,) in 1828, amounted to 550, of which there were 338 owned in the State of New York, 86 in Massachusetts, 53 in Connecticut, 29 in Rhode Island, 23 in New Jersey, 13 in Pennsylvania, and 8 in Maine. The total amount of capacity or tonnage was 37,443. The trade since then has very much increased. To straighten the course of the current. and to contract the width of the stream, wing dams or jettees at right angles with the shore have been proposed. The only example we have in this country of a river improved extensively on that plan, is the Connecticut between Hartford and Middletown. On the Hudson river it is true, wing dams or jettees have been constructed at four points, but in neither case have fully effected the objects for which they were built. The theory of wing dams, or works at right angles with the shore, is simply to contract the channel, increase the force of the currents, and to throw them into one continued course, so as to corrode the bottom of the stream, and to increase its depth.

In 1820, Mr. Butler recommended the plan I have alluded to, as being suitable for the improvement of the Hudson, and having answered well on the Connecticut. If we examine, however, the character of these streams, we will find that they differ in many respects. The width of the former is much more considerable than the latter. Its course is very direct, and its surface is broken by islands, while the Connecticut is very serpentine. The bottom of the latter stream is also a rolling sand, easily set in motion by currents, while that of the Hudson is a much more heavy and compact material, and the force of the ascending tides is much less in the Connecticut than it is in the Hudson. These local differences are of such a nature as to render it a matter of doubt if the application of the same rules and practical knowledge which we would find useful in one case, could be successfully applied in the other.

If the river should, however, be improved on that plan, it would require between Troy and New Baltimore 44 or 48 wing dams or jettees, and many of them would not be more than one-fourth of a mile apart; and we can readily conceive what a mass of obstruction they would present to the current, and how much more dangerous they would render the navigation of the stream at all the navigable periods of the year.

The wing dams or jettees at low water would check the descending mass, and form comparatively a still pool between each other, except at the end of the work and the shore, or, properly speaking, the opening or passage way. The operation is evident, the current being accelerated at the openings, as the channel is most contracted at that point, and its force diminishing gradually above and below it in the reaches between the dams, and also assisted by the lateral rush of water from the upper pond to pass through the opening. It is therefore evident that the soil would be swept out at that point, and deposited in the pond, before it reaches the dam immediately below. But the river now commences to rise, and flows over the

jettee, as the opening is insufficient to discharge it. Its speed being checked by the work, it sweeps over the dam with an increased velocity, and forces up the soil immediately below its base, which is carried down and deposited at some other point. On this plan, we therefore have 48 bars or shoals in motion, at times to the manifest injury of the navigation. It is true that, at low water, the jettees could be so harmonized as to create a certain repellent angle, or deflection of the current, nearly in a continuous straight line; but, as the river rose and overflowed them, these works would become more or less useless, and the river would wend its own way over them. But they would, however, create unequal currents, and endanger the navigation by the sudden formation of new bars and shoals. Nor is the improvement calculated to assist nature, by investing it with an increase of power in proportion to the speed of its currents; and what it does confer, is so diffused, as to produce but little useful effect.

It would add too much to the length of this report, to examine all the plans which have been proposed. I will therefore mention the one which I feel confidently assured will accomplish the improvement of the stream. It is, however, necessary to premise—

1st. That where channels are opened in a straight line with the direction of the currents, they will continue open unless injured by ice floods.

2d. That where piers are built parallel with the course of the stream, and of a height sufficient to contract its width, and to straighten its currents, the water corrodes the bottom, and increases the depth of the channel.

3d. By diminishing the width of the stream, and forcing it through a less space, we must raise the water, and increase the speed of the current, unless, by local excavation, we proportion the area of the new channel equal to the quantity of water flowing in the old.

4th. That channels nearest the centre of the stream are not so liable to fill as those opened nearer the shore, as the currents are stronger in the centre than at any other part.

5th. That the velocity of water passing through perpendicular piers or straight docks is equal in every part on its surface, and at equal depths.

The plan I therefore recommend, is, to excavate straight channels in the direction of the current through the different shoals and bars, of sufficient width and depth to accommodate the trade. To construct parallel or single piers afterwards, wherever necessary, to prevent the spread of water in the low state of the river, and to confine it to one channel; and to prevent too great velocity of current during floods, to let the water pass over the works. To secure the channel from being injured by the wash from the shores and islands, to protect their sides, wherever necessary, by wharfing, or by loose masses of stone. To place the soil excavated from the channels in the piers, or other secure places, to prevent it being again carried down by the stream. To have a dredge always at command, to remove any local obstructions after the works are completed, and to secure them against ice floods; to construct ice holders or breakers, and to provide beacons and monuments to assist in the night and day navigation of the river.

The reason why I propose local excavation before the construction of the piers, or at the same time, is to prevent the danger of the soil, if the piers were first constructed, being carried down and deposited in some new place. The ice being kept back by the proposed works, it would im-

pinge with less force, and in less masses and quantities than it would otherwise; and the soil being disposed of as I have suggested, there would be no danger of it again troubling the bed of the stream.

Dredging.—The changes which occur in the beds of all streams are of such a nature as would require more or less labor to remedy the injuries the channels might sustain. It would, therefore, be necessary that we should always have at command a power which we could apply to that purpose. That power is the dredge, and we can rely with confidence on its ability to perform such labor as we may require.

By the application of steam, the power and practical utility of the dredge has been much increased. It has also lessened the expense of excavations in a ratio corresponding with the improvements of its machinery and its strength: and, at this time, it may truly be considered as so important an agent, as to have rendered many river improvements attainable, which before were considered impracticable.

To obtain full information on the subject of the Albany steam dredge, I addressed a letter to General Gansevoort, of Albany, who had the kindness to procure for me the following information:

The expense of the dredge, and its appendages, was about $14,000. The annual expense of repairs about $250. The daily expense of fuel and labor about $20, and the durability of the machine, if used every season, about 7 years; and it can perform work between seven and eight months in the year.

The power of the machine is about 15 horses, working under high pressure, with boilers on each side. The buckets are 2 feet wide, and 1 foot deep, and oval form. A moderate and even power applied effects the best operation. Her present clearing is in 10 feet water, but can be made to operate in 14 feet water, if necessary.

The machine can remove from 50 to 60 cubic yards an hour in good digging. From hard bottoms and deep water, from 30 to 40 cubic yards in an hour, and has removed from the Overslaugh bar 600 cubic yards in a day.

The expense of the dredge, therefore, for seven months, or say 182 days, at $20 daily, would amount to 3,640 dollars; and to which add 250 dollars for the repairs of the machinery, making 3,890 dollars. If we suppose that the dredge could only work two-thirds of the time, the other one-third being interrupted by high water, and breaking of the machinery, and that the averaged excavation was 40 cubic yards per hour, and the time in which it operates ten hours, it gives 400 cubic yards as the daily labor of the machine, or 48,000 cubic yards is its total amount of work yearly. We have seen that the daily performance of the dredge, and the repairs of the machine, amount to 3,890 dollars. If to this we add the annual decay, and the loss of interest on the capital, it would give, in seven years' average, 2,400 dollars. But even after the machine was useless, some parts of it would be saleable. If we assume this as one-eighth of its original cost, it leaves 2,100 dollars, or 5,990 dollars as the total annual expense of the dredge, and the loss of interest, decay, and repairs of the machine, or nearly 12½ cents per cubic yard for the cost of excavation, on the amount of work which the machine is capable of performing to meet that sum.

Without entering into a minute calculation, we will assume, as the soil is now placed in scows to be taken away, that each craft will contain 20 cubic yards; or it will require 20 scow loads to carry away the soil which

the dredge would excavate, or 2 in each hour; consequently, one gang of men, comprising four persons, would be sufficient to attend to this part of the duty, at one dollar each; it gives the expense of transportation of earth to the place of its deposite at one cent per cubic yard, or making $13\frac{1}{2}$ cents per cubic yard for all expenses of digging and removing the soil.

This calculation may appear high, and is probably so. It is therefore safe. But it will be seen that I have supposed the work to be done by contract, and that the machines are owned by individuals. But if done directly by the Government, the work might be done lower than I have calculated it.

Basis of estimate. The averaged price of timber, at 10 cents per cubic foot; ties 6 inches diameter at small, and from 9 to 10 inches at large; $\frac{1}{3}$ quantity 36 feet long and $\frac{2}{3}$ feet long, which makes a merchantable quantity, at 90 cents per stick.

Brush under piers, with necessary labor to place them, at 75 cents per lineal foot.

Trunnels, at $1\frac{1}{4}$ cents each.

Iron worked into bolts, spikes, &c. at 160 dollars per ton.

Piles, and driving them, 2 dollars each.

Workmanship measured on one side of pier, 8 cents per superficial foot.

Plan of Pier.—The bottom of the stream, at the place the pier is to be built, to be covered with fascines composed of brush 2 feet thick, and extending six feet into the stream from the outer face of the docking, and four feet within. The head of the pier, where it does not abut against islands or the shore, to be strengthened by three rows of piles driven so as to touch each other, and extending the full width of the work, and secured to each other by bolts passing through cap-pieces, and others laterally passing through the sides of the piles, and secured to the down stream side of the lower row of piles, by having their ends slit and hammered.

The width of the pier on bottom to be 12 feet, and on top 10 feet. Ties to run across at every 10 feet, and each alternate row of ties to be so arranged as to be half way over the range of ties immediately below them. Piles to be driven on the inside of the pier and on the channel side every 10 feet, and on the opposite every 15 feet, and secured by bolts to every alternate layer of timbers. The pier to be raised two feet above common high water, and to slope on each side 1 foot in its height. The side timbers of each row will have to be cut levelling to meet it. The top of the pier to be covered with three inch plank, with smooth edges, and spiked and secured with bolts occasionally. The pier to be one-half filled with stone, and the balance with the soil taken from the river.

To build a pier on this plan may present some difficulty in placing and securing the timbers properly in deep water, but the depth is generally inconsiderable in which the piers would be erected, and the common means, which are adopted in erecting hydraulic works, could be resorted to. I have included piles in the estimate, as it is supposed it would render the work more secure, and prevent the pier sinking. The brush is proposed to be placed under the pier, to prevent it undermining by the currrents rushing by it. Other plans may occur, but this is supposed to be more permanent and secure than any other.

Estimate, head of pier.

36 piles, at 2 dollars each - - - -	$72 00
Timbers and carpenters' work - - - -	2 00
Iron and workmanship in fixing bolts - - -	4 88
Total cost - - - - -	$78 88

Estimated expense of a pier thirty feet long, twelve feet high.

5 piles, at $2 each - - - - - -	$10 00
720 cubic feet of timber, (sides,) at 10 cents each - -	72 00
10 ties, at 90 cents each - - - - -	9 00
Trenails and iron bolts - - - - -	7 20
3-inch plank - - - - - -	7 50
Spikes and bolts - - - - - -	4 00
Fascines under pier - - - - -	22 50
60 cubic yards of stone, at 60 cents - - -	36 00
60 do river soil, at 4 cents - - -	2 40
Workmanship, 360 square feet, at 8 cents - - -	28 80
Contingencies, 10 per cent. on amount - - -	19 90
Total cost - - - - -	$219 30

or an average of 7 dollars 31 cents per running foot.

The ice breakers are estimated at 50 feet long, 20 feet wide at their lower end, and presenting to the stream at the upper a triangular front, being 20 feet at base, 10 feet long, and 10 feet wide at the upper end. The whole surface of the pier to recede or batter $1\frac{1}{2}$ inches to each foot in height. The side timbers to be connected with ties trenailed and bolted. The bottom of the stream in which the work is to be built to be selected nearly as level as possible, and fascines, composed of brush, to be used in the same manner as under the piers. The inside of the work to be filled with stone placed compactly in it. If the depth of water should be considerable the timbers would have to be joined together, and the frame sunk by placing stone on it, as would likewise the brush.

Estimated expense of an ice holder on the above dimensions, and twenty feet high.

1,680 cubic feet timber, at 8 cents - - -	$134 40
30 ties, cut into pieces from 10 to 20 feet long, at $1 -	30 00
Bolts and trenails - - - - -	100 00
Fascines - - - - - -	40 00
Workmanship - - - - - -	120 00
296 cubic yards of stone, at $1 - - - -	296 00
Contingencies, 20 per cent. - - - -	144 00
Total - - - - - -	$864 40

The permanent monuments and lights are estimated as being square pillars, placed on the shores or islands. They would be constructed of stone or brick, coated with plaster, and covered with whitewash. They

would be furnished with a lantern; and wooden steps or a ladder would be provided to ascend and to attend to them.

The stone work is estimated at - - - - -	\$75
The lantern, &c. - - - - - - -	50
Total - - - - - - -	\$125

Floating lights might be necessary at some points; they would be placed on floats constructed for that purpose. They might, however, be objectionable, as they would be seen but a short distance, and the pilots might not discern them very readily.

To protect the sides of the islands, it is proposed to dock or wharf them; the estimate which is fixed on for that purpose, is \$2 per running foot.

The width of the channel to be opened between Waterford and Troy is 90 feet, between Troy and Albany 150, between Albany and New Baltimore 200 feet.

The actual quantity of excavation is increased one-fourth, allowed on account of the setiling of the soil in the channel cut, and the dredge operating sometimes out of the channel to be opened, and for other contingencies which may not have been considered in the dimensions given.

The depth at extreme low water will not be less than 9 feet in any of the channel proposed to be opened.

Estimate.

44,095 cubic yds., &c., between Waterford and Troy, at 13½ cts.	\$5,952 82
Pier from island to west shore, 750 feet, at \$7 31 per foot -	5,482 50
3 monuments and lights, at \$125 each - - -	375 00
Protecting side of island, 3,940 feet, at \$2 per foot - -	7,880 00
Contingencies - - - - - - -	1,969 00
Total cost of improvement between Troy and Waterford	\$21,659 32
178,105 cubic yards between Troy and Albany, at 13½ cents	\$24,044 17
3,800 feet pier between Troy and Albany, at 731 cents -	27,778 00
Protecting side of islands and shores, 8,700 feet, at \$2 -	17,400 00
3 monuments and lights, at \$125 each - - -	375 00
4 ice holders, at \$864 40 each - - - -	3,357 60
Contingencies - - - - - - -	7,295 40
Total amount improving river between Troy and Albany,	\$80,250 17
231,759 cubic yards, sheets No. 4 and 5, at 13½ cents -	\$31,297 46
5,280 feet pier, at 731 cents per foot - - -	38,596 80
Protecting sides of islands, 6,648 feet, at \$2 - -	13,296 00
4 ice holders, at \$864 40 each - - - - -	3,357 60
3 monuments and lights - - - - - -	375 00
Cutting off end of Winnie's pier - - - - -	100 00
Contingencies - - - - - - - -	8,702 20
Total cost of improvements on sheets No. 4 and 5 - -	\$95,725 06

23,330 cubic yards excavation, at 13½ cents	- -	$3,149 55
Protecting sides of islands, 6,300 feet, at $2	- -	12,600
Monuments and lights, at $125 each	- - -	950
Straightening channel	- - - - -	5,000
Contingencies	- - - - - -	2,169
Total	-	$23,868 55

Recapitulation.

Estimated expense between	Waterford and Troy	- -	$21,659 32
Ditto	Troy and Albany	- -	80,250 17
Ditto	Albany and end of survey	-	119,594 61
Total estimated expense of improving river		-	$221,504 10

The above estimate is very liberal, and I have no doubt that the work will be done within it.

I cannot refrain from giving the following extract from the able and interesting report of Edmund Chas. Genet, on the subject of a ship canal from Albany. It is proper to remark that, however much I esteem the opinions of that gentleman, in the necessity of this improvement I do not agree with him; and that I am satisfied that the improvement of the navigation of the stream will better serve the interest of commerce, and be more beneficial to the cities of Albany and Troy, and be more permanent in its nature than the proposed ship canal.

"The idea of a ship canal has, I know, been received with diffidence and reserve by several commissioners, who did not, at the first glance, see into the practicability and utility of a measure of that magnitude. It was apprehended that the ridges of rocks, overhanging in many places the shore traversing the river, would oppose insurmountable barriers to the deep digging requisite to procure a convenient navigation of ships without the assistance of locks. It was also imagined that the fall of the ground would render intermediate locks indispensable. The filtration of the water of the river through the soil was considered as another impediment, and the soil, supposed to consist of quicksand, did not seem proper to form the embankment of a canal without the support of expensive facings in stone or timber."

"I have myself voluntarily imposed these preconceptions of my mind, and approached my plan with the severity of a judge; but the surveys, borings, and geological observations have incontestably proved that a uniform depth of 21 feet may be excavated on the line of the projected canal, *without a single obstacle.* That the soil, being compact, will require no facing to support the embankment; that no filtration from the river seems to penetrate the alluvial bed. That the average fall of the ground does not exceed one foot and a half. That the high tides, between Albany and Schodac, are on a level at high water, and, consequently, locks will not be wanted if the canal was dug to a sufficient depth to check a small current more useful than it is detrimental in canals of that kind, if the opinion of the English engineer, William Chapman, may be credited on that point."

"The entrance would be located at the lower part of the dock at Green-

bush, at a place where the water is, at the low water mark of last summer, from 13¾ to 18½ feet as far as the lower docks of Albany. Its peculiar construction would be a pier built, in stone, as high as the embankment of the canal, and parallel to the river; and the gates supported by that fabric would have the same elevation as the canal embankments.

"The outlet would be located at a place called Vyode Hook, below Coeyman's overslaugh, and between Coeyman's and New Baltimore, where, at the lowest water, there is a depth of $13\frac{7}{10}$ feet. That pier would also be supplied with a gate; and, as the service of these two gates would only be to exclude drift and ice during freshets, they would be shut at no other time than at these periods. The canal would be $18\frac{7}{10}$ feet deep at high water, the bottom 35 feet wide, and the surface of water $109\frac{3}{10}$ feet; the whole being calculated for the passage of 2 ships of 600 tons, or 2 sloops loaded with boards."

"The eastern embankment would have the same elevation as the western embankment, but only half the breadth; and as those two embankments would not consume the whole of the excavation, the surplus extracted from the surface would be disposed of on the adjoining low lands. Grated sewers would convey into the canal the water descending from the hills, after having been settled into appropriate reservoirs; and where it should be requisite for the trading places on the line of the canal accommodation, gates and drawbridges might be provided.

"The course of the canal would be from Greenbush, through the flats and a creek, to the front part of the village of Castleton; thence, through meadows and islands, to the Schodac creek as far as Schermerhorne's store; from thence, in an oblique direction, it would reach, through an island and a creek, the outlet at the Vyode Hook. Such a canal would, in reality, be but an artificial branch of the river, protected against the alluvial deposites and floating ice in the whole of its extent, and participating in all the known advantages of canals for celerity, safety of navigation, straightness of course, and the facility for vessels using sails to be towed against contrary winds. It would also be navigable later and earlier than the river: the ice, on account of the heat of the springs coming from the land, being known to dissolve earlier in the creeks which receive it than in the main river; and the navigation being more impeded in the fall by the floating ice coming from the north, and that by the general congelation of the stream. It is also well known that, at the place the outlet of the canal will intersect the river, it keeps open every year about a fortnight earlier in the spring, and a fortnight later in the fall, than at Albany; and if, owing to those circumstances, towing boats, supplied with stumpers similar to those employed on the Forth and Clyde canal, were also used on the lateral canal to break the ice before and after the heavy frosts, as it has been of late years practised at the ferry of Albany, the navigation of the river might gain a month in severe winter, and more if the winter was mild."

The estimated expense of building the canal amounts to 727,715 dollars. He also calculates one 6¾ miles long, $14\frac{2}{10}$ feet deep, 30 feet wide at bottom, and $72\frac{6}{100}$ at top, at 158,187 dollars, exclusive of the expense of superintendence.

Having presented as full a report as the nature of the examinations will admit, and exhibited the manner and the estimated expense of improving the navigation, I cannot conclude without expressing my own decided

conviction that that measure is the best calculated to accomplish all the objects intended to be secured by those interested in the navigation of that noble river.

The jurisdiction of the General Government over the waters of the Hudson has been fully acquiesced in by public sentiment, and by judicial decisions. It is also connected by canals with our great Western and Northern lakes. Its improvement is not, therefore, local, nor its benefits confined to the citizens of the State of New York; for, however beneficial it may be to that great and flourishing portion of our country, its advantages must extend to other and more remote regions, and benefit proportionably the citizens of foreign States and communities, who trade on its waters, and receive their supplies, or send their commodities, through those artificial channels created by the foresight, munificence, and labors of a patriotic people.

I recommend to the most favorable notice of the department George W. Hughes and Charles N. Hagner, Esquires, United States assistant civil engineers, for the frank performance of their duties, and their industry in the field; and to their joint labors I am indebted for the early completion of the drawings which will be transmitted in the course of a few days.

DE WITT CLINTON,
U. S. Civil Engineer.